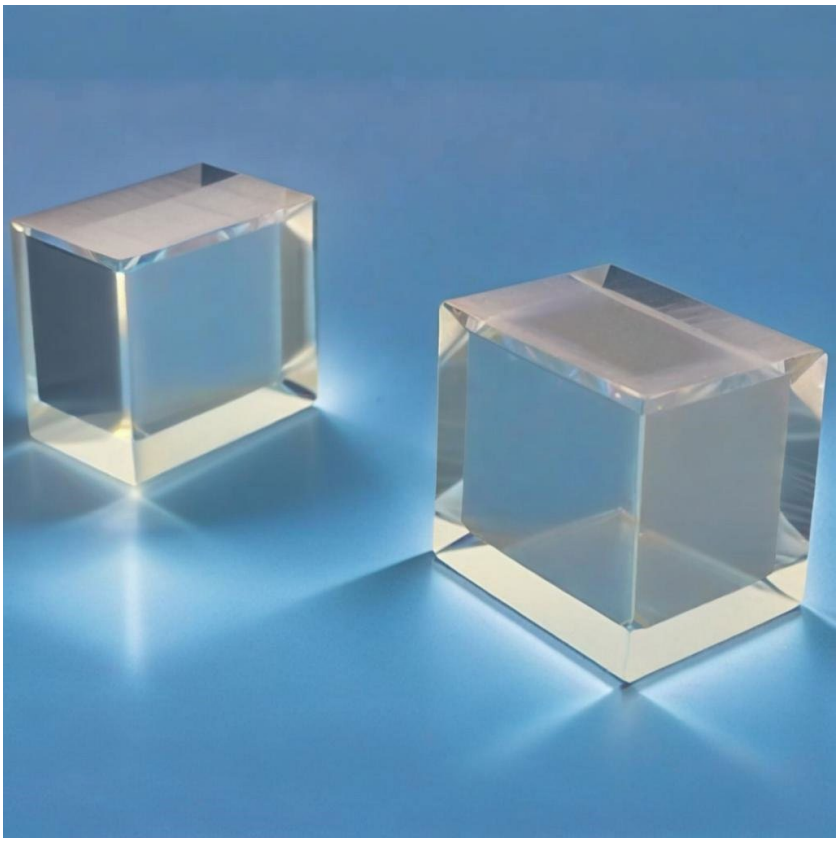
Photonics On Crystals

POC-OC-122406-KTP Crystal

1. **1. Main Features**

- **Wide Nonlinear Optical Coefficient**: Offers high nonlinear optical efficiency for a variety of laser applications.
- **Broad Angular Bandwidth**: Low walk-off angle ensures enhanced beam quality and stability.
- **Wide Transparency Range**: Operates effectively within 350 nm to 4500 nm for various wavelengths.
- **High Electro-Optic Coefficient**: Low dielectric constant with exceptional electro-optic properties for E-O modulators.
- **Chemical and Mechanical Stability**: Non-hygroscopic, thermally robust, and mechanically durable for extended usage in diverse environments.



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2. Material General Description

Potassium Titanyl Phosphate (KTP) is a versatile nonlinear optical crystal widely utilized in commercial and scientific applications due to its superior optical properties. With a high nonlinear optical coefficient, KTP is a preferred choice for frequency doubling of Nd:YAG lasers and other laser systems operating at low to medium power. Its broad angular bandwidth and minimal walk-off angle make it ideal for producing high-quality beam output. The non-hygroscopic nature of KTP ensures long-term durability, even in challenging environments. Additionally, KTP crystals exhibit excellent

electro-optic coefficients, making them highly suitable for electro-optic modulators, waveguides, and optical communication systems.

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3. General Applications and Examples

KTP crystals are renowned for their extensive applications in photonics and laser technology:

- **Frequency Doubling**: Commonly used to double the frequency of Nd:YAG lasers to generate green light at 532 nm. Examples include producing green lasers with 80% conversion efficiency.
- **Optical Parametric Oscillators (OPOs)**: Generates tunable wavelengths from 600 nm to mid-infrared (4500 nm). Applications include laser source development for LiDAR and environmental monitoring.
- **Electro-Optic Modulation**: Excellent performance as modulators in optical communication systems due to high electro-optic coefficients.
- **Intracavity and Extracavity Frequency Conversion**: KTP crystals efficiently generate blue and red light through intracavity SHG of Nd:YAG lasers.
- **Waveguide Applications**: Low-loss optical waveguides for integrated photonics, including parametric devices and laser amplifiers.

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4. Chemical and Structural Properties

Below is a table consolidating the chemical and structural attributes of KTP:

Property	Value
Crystal Structure	Orthorhombic, Space group $Pna2_1$, Point group mm^2
Lattice Parameters	a = 6.404 Å, b = 10.616 Å, c = 12.814 Å
Melting Point	~1172 °C
Mohs Hardness	5
Density	3.01 g/cm³
Thermal Conductivity	13 W/m·K
Thermal Expansion Coefficient	$a_a = 11\times10^{-6}$ /°C, $a_\beta = 9\times10^{-6}$ /°C, $a_a = 0.6\times10^{-6}$ /°C

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5. Optical and Nonlinear Optical Properties

A detailed comparison of optical properties:

Property	Value
Transparency Range	350–4500 nm

SHG Phase Matchable Range	497–1800 nm (Type II)
Thermal-Optic Coefficients ($°C^{-1}$)	$dn/dT = 1.1 \times 10^{-5}$, $dn/dT = 1.3 \times 10^{-5}$
Absorption Coefficients (cm^{-1})	<0.1% @ 1064 nm, <1% @ 532 nm
NLO Coefficients	d_{33} = 13.7 pm/V, d_{31} = 6.5 pm/V
Walk-off Angle	0.55° @ 1064 nm
Sellmeier Equations (λ in μm)	$n_x^2 = 3.0065 + 0.03901 / (\lambda^2 - 0.04251) - 0.01327\lambda^2$
Dielectric Constant	$\varepsilon_r = 13$

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6. Spectrum Transmission Curves

Spectrum transmission curves are available upon request, showcasing the high transparency of KTP within the 350 nm to 4500 nm range.

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7. Coating Specification

KTP crystals can be provided with high-quality coatings to enhance their optical performance:

- **AR Coating**: Dual-band and broadband anti-reflection coatings for 1064 nm and 532 nm.
- **High Reflective Coatings**: Ensures reflectivity >99.8% for specific laser wavelengths.
- **Custom Coatings**: Available upon request for specific operational requirements.

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8. Standard Fabrication Specifications

Specification	**Value**
Dimension Tolerance (mm)	W × H (± 0.1) × L (± 0.5/± 0.1)
Angle Tolerance	$\Delta\theta \leq 0.25°$, $\Delta\phi \leq 0.25°$
Parallelism	<20 arc seconds
Perpendicularity	<5 arc minutes
Chamfer	0.1 mm @ 45°
Surface Quality	10/5 Scratch/Dig
Surface Flatness	λ/8 @ 633 nm
Damage Threshold (GW/cm^2)	>1.0 @ 1064 nm, >0.3 @ 532 nm

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9. POC Strength and Capabilities

KTP crystals offer unmatched versatility and strength in photonics applications. Their ability to function across a broad wavelength spectrum with low absorption and high efficiency makes them an ideal solution for laser systems. The high damage threshold ensures reliability under intense operational conditions. Furthermore, the non-hygroscopic and chemically stable nature of KTP enhances its durability and reduces maintenance requirements, making it a cost-effective choice for both research and industrial applications.

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10. Standard Products

Face Dimensions	Length	Theta	Phi	Coatings	Application	Price (USD)
3×3 mm	5 mm	90°	23°	AR@532+1064nm	SHG@1064nm Type I	$110
5×5 mm	10 mm	90°	23°	AR@532+1064nm	SHG@1064nm Type I	$150
7×7 mm	20 mm	90°	23°	AR@532+1064nm	SHG@1064nm Type I	$200
Custom	Custom	Custom	Custom	Custom	Custom	Inquire